

DOCUMENT RESUME

ED 334 611

CS 507 511

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TITLE The Effects of Tactile Stimulation and Gross Motor Movement on Cognitive Learning: A Test of Montessori's Muscular Movement Theory in the College Classroom.
PUB DATE Apr 91
NOTE 24p.; Paper presented at the Annual Meeting of the Eastern Communication Association (Pittsburgh, PA, April 25-28, 1991).
PUB TYPE Reports - Research/Technical (143) -- Speeches/Conference Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Classroom Research; Educational Research; Higher Education; *Learning Processes; *Montessori Method; Nonverbal Communication; Perceptual Motor Learning; *Physical Activities; *Tactile Stimuli; Undergraduate Students
IDENTIFIERS Communication Context; *Montessori (Maria)

ABSTRACT

Three theories have been proposed to explain the relationship between nonverbal behavior and cognitive learning: arousal theory, depth-of-processing theory, and muscular movement theory. The first two theories place emphasis on the role of the teacher and have been empirically tested. The third theory, muscular movement (which suggests that the physical involvement of the student will increase cognitive learning), places emphasis on the behavioral role of the student and has received less attention from empiricists. A study examined whether the use of tactile stimulation in conjunction with motor movements would enhance cognitive learning. Subjects were 41 students in an upper level communication research methods class. A lecture (dealing with operationalization, measurement, and reliability and validity) was presented to one group, and the same lecture was presented to a second group with the addition of three tactile/motor exercises. Results indicated a significant relationship between the nonverbal behavioral participation of students and cognitive learning as assessed through exam scores. Findings suggest that students who are physically involved in the content of the lecture score higher on their exams than students who only listen to the lecture even though those students receive similar examples and similar levels of immediacy. (Two tables of data are included and 33 references are attached.) (SR)

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The effects of tactile stimulation
and gross motor movement on cognitive
learning: A test of Montessori's muscular
movement theory in the college classroom.

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1991

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ABSTRACT

A considerable amount of research has been dedicated to understanding the relationship between teacher behaviors in the classroom and student learning. Elsewhere, three theories (i.e., arousal theory, depth-of-processing theory, and muscular movement theory) have been proposed to explain increases in cognitive learning. Both arousal theory and depth-of processing theory have been empirically tested in communication contexts. The current investigation tested the viability of muscular movement theory in a communication classroom. A field experiment was conducted to determine if the use of tactile stimulation in conjunction with gross motor movement exercises would increase cognitive learning (i.e., examination scores) of college students. The results of an Anova support the research hypothesis and promote the use of nonverbal participation by students in the college classroom in order to increase learning.

Several communication scholars have investigated the role nonverbal communication plays in learning (Andersen, 1979; Andersen, Norton, & Nussbaum, 1981; Gorham, 1988; Richmond, Gorham, & McCroskey, 1987; Woolfolk & Brooks, 1985). Although their endeavors have revealed relationships between the nonverbal behaviors of the teacher and affective learning (i.e., desire and attitude toward learning), the relationship between nonverbal behaviors and cognitive learning (e.g., comprehension), has been tentative at best. Three theories have been proposed to explain the relationship between nonverbal behavior and cognitive learning. They are arousal theory (Yerkes & Dodson, 1908), depth-of-processing theory (Ortony, 1978), and muscular movement theory (Montessori, 1929/1967, 1909/1964). The first two theories place emphasis on the role of the teacher and have been empirically tested (Kelley & Gorham, 1988; Folger & Woodall, 1982, respectively). The third theory, muscular movement, places emphasis on the behavioral role of the student and has received less attention from empiricists. The purpose of the present investigation is to address the viability of muscular movement theory with respect to the link between nonverbal behavior and cognitive learning in the classroom.

Teaching-Learning Process

In the mid to late 60's classical learning theory which was accepted widely and quickly across the United States, gave way to several other accounts of learning (Pressey, 1963; Gage, 1964). Bloom's (1956) taxonomy of learning objectives has gained respect for its elegance and has been widely used by communication

scholars.

Bloom's (1956) classic taxonomy of educational outcomes consists of three major learning domains: cognitive, affective and psychomotor. Bloom (1956) defined cognitive learning as varying from "simple recall of material learned to highly original and creative ways of combining and synthesizing new ideas and materials" (Bloom, 1956, p. 6). Affective learning was described as the attitude, interest or appreciation a student develops about learning. Finally, psychomotor learning was defined as those skills that require "neuromuscular co-ordination" such as the dexterity involved in handwriting or gymnastics in physical education (Bloom, 1956, p. 7). Each of the domains have been considered interrelated.

Gage (1964) noted that teaching-learning theories that were heavily weighted on the learning side could be reversed to adapt the teaching side as well. According to Gage, the distinction among learning domains was generalizable to teaching domains. That is, cognitive teaching is used when the instructor explains or describes concepts; affective teaching is achieved through the warmth or enthusiasm of the instructor; and psychomotor teaching is displayed when the instructor behaviorally demonstrates the skill being taught such as writing a letter of the alphabet or doing a jumping jack before the student attempts the skill. Based upon Gage's incorporation of teaching into Bloom's taxonomy of learning, teaching can be categorized into one of three domains. For example, teacher immediacy would be considered a form of affective teaching. Similar to the learning domains, the teaching domains should be considered interrelated.

Thus far, communication scholars have predominantly focused in the area of affective teaching (e.g. teacher immediacy) in relation to affective, behavioral, and cognitive learning. Much of the research has shown discrepancies between affective teaching and cognitive learning.

Affective Teaching and Cognitive Learning

Teacher immediacy is a well developed construct, which was introduced by Mehrabian (1969) and is exemplified through the nonverbal behaviors of the teacher such as using propinquity and a relaxed posture, eye contact, head nodding, smiling, being vocally expressive, and orienting one's body direction toward the students (Andersen, Norton, & Nussbaum, 1981). These nonverbal behaviors were expected to be significantly related to student learning. Andersen (1979) found a significant relationship between teacher immediacy and affective learning, but not cognitive learning.

In an attempt to understand this discrepancy Andersen et al. (1981) conducted three studies addressing teacher style and affective, behavioral, and cognitive learning. Cognitive learning was measured using a 50-item multiple choice exam and was administered to college students. In discussion of the three studies, the authors concluded that the relationship between teacher immediacy and cognitive learning was still inconclusive. While significance was found, the variance explained was so low that the authors could not support a relationship between teacher immediacy and cognitive learning.

A replication of Andersen's work by McDowell, McDowell, and

Hyerdahl (1980, as cited in Richmond, Gorham, & McCroskey, 1987) revealed similar results. The correlations between immediacy and cognitive learning were quite low.

Richmond et al. (1987) recommended the use of an alternative means of measuring cognitive learning. The authors offer a cogent argument based on the rationale that college students are experienced in academia, mature individuals and quite capable of assessing how much they have learned in the class. Thus, the subjective measure of cognitive learning asked college students to recall how much they learned in a particular class. Then the students were asked to recall the immediacy level of the teacher who taught that particular class. The results of the study suggested that immediacy was significantly related to cognitive learning explaining approximately 50% of the variance. Furthermore, cognitive learning showed a nonlinear relationship to immediacy with moderate and high immediacy teachers producing approximately the same effect on student learning.

Gorham (1988) introduced verbal immediacy behaviors into the teaching-learning model and continued to measure cognitive learning in a subjective manner by asking students to report on a Likert-type scale how much they had learned in the class. The results indicated a significant and meaningful relationship between verbal and nonverbal immediacy behaviors and cognitive learning. Further support for a relationship between perceived learning and teacher behaviors has been reported by Christophel (1990), Hackman and Walker (1990), Richmond (1990), and Sanders and Wiseman (1990).

Operationalizing Cognitive Learning

Debate over the inconsistencies in the literature relating teacher behaviors with cognitive learning has focused on the measurement of cognitive learning. Researchers have moved from generally accepted measures for assessing cognitive learning in the classroom (i.e. tests, papers, or course grades) to a subjective measure asking student's to report how much they have learned.

Baird (1987) reported a high correlation between students' perceived learning and the overall evaluations of the course and the professor's teaching ability. "Clearly, these data support the superiority of subjective learning as a predictor of student ratings of university instruction. The practical implication is that students' ratings of instruction are much more a function of the perceived quality of teaching (the validity hypothesis) than of the grade expected (the grading leniency hypothesis)" (Baird, 1987, p. 91). Obversley, Cohen (1981) reported a moderate correlation between subjective reports of learning and examination scores.

In an attempt to move away from the subjective measure of cognitive learning, Allen and Shaw (1990) used the subjective rating by the supervisor rather than the student to measure cognitive learning. Kelley and Gorham (1988) used a recall measure to address the relationship between cognitive learning and immediacy. The results of their study indicated that propinquity and eye contact did affect cognitive learning.

In an effort to maintain reality isomorphism, the present

investigation supports the use of standard measures of cognitive learning. That is, if the classroom teacher uses tests, term papers or projects to assess the student's cognitive learning then that approach should be maintained in research studies. While the generally accepted standard means of assessing student knowledge may be inadequate, it is currently the accepted practice in most public and private schools.

Theoretical Explanations of Cognitive Learning

Arousal Theory

Kelley and Gorham (1988) explained the results of their study via arousal theory. The authors offer the explanation that cognitive learning is increased when teachers use immediacy because additional nonverbal behaviors of the teacher arouse the attention level of the student. Arousal theory was first introduced through the work of Yerkes and Dodson (1908) who discovered a non-linear relationship between arousal and task performance. Specifically, the authors reported that performance deteriorates when arousal is either too low or too high. Thus, moderate arousal evokes the highest performance efficiency.

Depth-of-Processing Theory

Ortony (1978) suggested that it is critical to distinguish the different aspects of cognitive processing, especially the difference between memory and comprehension, in order to develop a theoretical premise to explain cognitive learning. First, memory is comprised of both recognition and recall. Comprehension is exemplified through integration of ideas and the ability to make inferences. Recognition and recall occur after

initial comprehension has taken place. However, the two may not be totally distinct domains. Ortony suggested that both comprehension and recall are related to an activation process that may be dependent upon both the context and the depth at which the information is processed.

Folger and Woodall (1982) argued that deeper processing may be affected by nonverbal communication within specific contexts. The authors proposed that anomalous, ambiguous, or incongruent situations may encourage people to rely on both verbal and nonverbal components of the message. Subsequently, individuals would process information in more elaborate ways. Further, the authors proposed that more symbolic nonverbal gestures carry more information than less symbolic gestures and thus require more elaborate or deeper processing to occur. Consequently, individuals who are presented with a less than straight forward message or who encounter the use of symbolic gestures use more stimuli to process the information which in turn activates more nodes within the cognitive processing network.

Folger and Woodall (1982) suggested that the use of more symbolic nonverbal cues should enhance cognitive processing by activating a greater number of nodes. The authors tested their hypothesis by providing respondents with video tapes of confederates relaying a message using either motor primacy gestures (i.e., emblems with semantic meaning) or speech primacy gestures (i.e., batons or illustrators which carry no semantic meaning) and testing their recall of the message when the video was played back without the sound. The results supported that motor primacy gestures significantly increased recall over speech

primacy gestures (Woodall & Folger, 1981).

Both arousal theory and depth-of-processing theory have been tested in terms of the teacher's behavior. Recently, scholars have allowed a teacher-oriented perspective to dominate the literature (Andersen, 1979; Andersen, Norton, & Nussbaum, 1981; Gorham, 1988; Guba & Getzels, 1955; Plax, Kearney, McCroskey, & Richmond, 1986; Richmond, Gorham, & McCroskey, 1987; Woolfolk, & Brooks, 1985). For example, the majority of studies that address nonverbal communication focus on the nonverbal participation of the instructor (i.e., teacher immediacy). A third theory which promotes a similar activation process as explanation to cognitive learning is muscular movement theory. Muscular movement theory lends itself to testing the activation principle through the nonverbal behavior of the student rather than the teacher.

Muscular Movement Theory

A possibility exists that the nonverbal communication required to increase cognitive learning is dependent upon both the teacher and the student. While the teacher must introduce certain concepts and experiential programs, the student must actively participate. Kane (1984) suggested that due to brain lateralization some students learn better with more tactile stimulation. Montessori (1929/1967; 1909/1964) recommended that children be introduced to abstract concepts through a sensorial approach.

Montessori (1909/1967) suggested that learning is a holistic process requiring both physical and mental involvement. Based upon her medical background, Montessori suggested that the

circulatory system (heart centered) and the nervous system (brain centered) were ordered and protected by the muscular system. She maintained that the muscular system aids in circulation and in locomotor and sense organ activities. Thus, "it is through his muscles that a man can act on his external world and give impressions to his thoughts" (Montessori, 1909/1967, p. 77).

Montessori (1909/1967) felt that "teachers erred in letting the senses and muscles of their pupils remain unused and inert while their thoughts wandered about in idle fancies. And yet the muscles, nerves, and senses all constitute a whole. If the disorder is to be corrected, the organs connected with the psychic life must be activated" (p. 78).

In the early 1900's Montessori experimented with sensorial, and especially tactile activities as teaching methods for young children. The role of the teacher was to explain the concept and simply direct the students toward didactic materials which would enhance the lesson. Children were given blocks, rods, or beads to assist in understanding numerals and numeric functions. Furthermore, the young students were physically involved with moving the didactic materials, requiring muscular movement while experiencing tactile stimulation. According to Montessori (1929/1964; 1909/1967), the combination of effort with muscular movement and tactile stimulation enhanced both recognition and recall by the students.

Studies of the Montessori approach focused on pre-school students' performances in mathematical areas of classification, seriation, one-to-one correspondence, comparison, rational counting, and recognition and comprehension. A review

of these studies showed that "Montessori was correct more often than not" (Bauch, & Huei-Hsin, 1988, p. 9). Specifically, the young students showed superiority in seriation, classification, and conservation (White, Yussen, & Docherty, 1976), as well as, cognitive tasks and memory problems (Yussen, Mathews, & Knight, 1980).

Research Question and Hypotheses

Arousal theory, depth-of-processing theory and muscular movement theory suggest that cognitive learning is dependent upon the activation of nodes. Arousal theory suggests that any nonverbal behavior that increases the attention of the students results in increased recall. Depth-of-processing theory suggests that symbolic nonverbal behaviors will increase cognitive learning over simple immediacy behaviors. Muscular movement theory suggests that the physical involvement of the student will increase cognitive learning. It is this later theory which has not been tested in the college classroom. Consequently, the research question for the present investigation is whether incorporating muscular movement on the part of the students will affect their cognitive learning?

- H1: Didactic learning activities which combine gross motor movements with tactile sensations will increase cognitive learning.

Method

A field experiment was conducted to test whether the use of tactile stimulation in conjunction with motor movements would

enhance cognitive learning of college students. A description of the participants, materials, and procedures follows.

Subjects

Fourty-one students enrolled in an upper level communication research class acted as the subjects for the field experiment. The research methods class is not mandatory for communication majors.

Materials

Didactic materials used in the field experiment include a dart board and darts, four plastic cups filled with materials of varying weights, and a tape measure. The dart board and darts were used to explain reliability and validity. The cups filled with different materials were used to explain the concept of ordinal measurement. The measuring tape was used to explain the concept of ratio measurement.

Procedures

The students were randomly assigned, using alphabetical ordering of their last names, for either Group One or Group Two. Group One acted as the control and Group Two acted as the stimulus group. Students were asked if they had any prior experience in research methods. Two students reported having taken a similar class in another department. One student reported dropping the class in a previous quarter. In order to ensure that the past experience of these three students would not affect the experimental design a randomized pretest - posttest design was used.

Two lectures were presented before the pretest was

administered. The lectures were based upon chapters from Contemporary Communication Research Methods by Mary John Smith (1988). Questions for the quiz were taken directly from the instructor's manual for the text.

The manipulation used in the field experiment was based on presenting the lecture in the same format as the previous two lectures to Group One, and presenting the same lecture to Group Two with the addition of three tactile/motor exercises. The lecture dealt with operationalization, measurement, and reliability and validity. The lecture was based on an outline from chapter three of Contemporary Communication Research Methods. The instructor inserted three examples into the lecture which included: (1) describing ordinal measurement by pantomiming that she had four cups in front of her, one filled with rubber bands, one filled with paper clips, one filled with m & m's, and one filled with pennies, the instructor pretended to lift each cup and address the concept of heaviness being measured in an ordinal manner, (2) describing ratio measurement by pantomiming that she had a measuring tape and suggesting that if they were to measure each student in the class with the measuring tape they would have a ratio measure of their height, (3) describing reliability and validity by drawing circles on the board to replicate a dart board and using chalk to mark off hits that demonstrated reliable, but invalid hits (i.e., the marks were close together, but none hit the bull's eye) and by showing marks that demonstrated validity.

The experimental group received the same lecture, but

instead of pantomiming the lifting of cups, describing the tape measuring of student's height, or drawing the target on the chalk board, the instructor brought these items into the classroom. Each of the students picked up the cups and marked down on a sheet of paper the order from lightest to heaviest. Each of the students was measured against the wall. Finally, each of the students threw three darts at the dart board. These activities were set up in three different areas of the classroom. The students walked about and selected the activity in whatever order they wished.

The experiment was tested using an analysis of variance. Tactile stimulation coupled with gross motor movements acted as the independent variable and cognitive learning as assessed through multiple choice exam scores acted as the dependent variable.

Results

Results of Preliminary Analyses

Questions for the two quizzes were taken directly from the instructor's manual. Each quiz consisted of ten multiple choice or fill in the blank items. The quizzes showed generally normal distributions (see Table 1).

Insert Table 1

Results of the Analysis

The results of the pretest were assessed via an analysis of variance (ANOVA) which supported that the two groups were not significantly different ($F = .06$; $df = 1/39$; $p = .81$). The mean

for Group One was 6.6 and the mean for Group Two was 6.8.

An ANOVA was used to test the differences between the control group and the experimental group for the manipulation using gross motor skills with didactic materials (i.e., lifting weighted cups, measuring height, and throwing darts). The results of the analysis of variance suggest that the experimental group did significantly better on the exam scores ($F = 8.32$; $df = 1/38$ $p < .05$). The mean for Group One (i.e., the control group) was 5.6, while the mean for Group Two (i.e., the experimental group) was 7.3. The direction of the means supports the hypothesis that the use of gross motor skills with tactile didactic materials increases cognitive scores. Furthermore, 18% of the variance was explained by the model. Thus, Hypothesis One was supported (see table 2).

insert table 2

Discussion

Gage (1964) argued that a variety of theories may be relevant to the teaching-learning process and more than likely several need to be combined in order to understand teaching-learning. Support has been garnered for arousal theory, depth-of-processing theory and now muscular movement theory. The results of this field experiment suggest a significant relationship between the nonverbal behavioral participation of students (i.e., Montessori's muscular movement) and cognitive learning as assessed through exam scores.

It is important to note that field experiments lack the control of laboratory experiments. For instance, in order to reduce

experimenter bias and maintain a similar level of teacher immediacy, the same instructor gave all the lectures. By choosing to use the same instructor at different times the factor of time delayed testing came into question. From the optimist's view point Group One received more time to study for the exam; from the pessimist's view point Group One had more time in which to forget what was taught. According to Kardash, Lukowski, and Bentmann (1988) delayed testing has no effect upon test performance when comparing students of different analytical styles.

Furthermore, muscular memory has largely been associated with mathematical concepts. The present investigation was no exception. While communication research methods are not entirely mathematical many of the concepts involve mathematical skills. Therefore, future research should address whether muscular memory technique can be applied to other classroom subjects, such as interpersonal communication, mass media, small group, organizational or nonverbal communication.

In addition, the results of the present study give rise to several interesting questions. First, if teaching methods can be categorized in a similar fashion to Bloom's learning taxonomy, is there a correspondance between teaching domains and learning domains? For example, can certain teaching methods be categorized as being more affective in nature (e.g., teacher immediacy) and thus have a greater effect on affective learning? Or can other teaching methods be deemed more cognitive in nature (e.g., use of speech primacy gesture or the Montessori method) and have greater

impact on cognitive learning? Although Gorham and Zakahi (1990) reported no significant relationship between teacher affect and teacher immediacy, it may not be due to flawed conceptualization. Rather, the authors suggested that the findings may be due to limitations of the affective teaching measure.

Secondly, is it possible that operationalizations of cognitive learning represent more affective, behavioral or cognitive assessments? In other words, is asking students to report how much they have learned demonstrating an affective operationalization of cognitive learning; is testing students via exams demonstrating a cognitive operationalization of cognitive learning; and is asking students to perform (e.g. conduct a study for research methods) demonstrating a behavioral operationalization of cognitive learning? These questions pose possibilities for future research.

Clearly, the teacher is responsible for classroom organization and management, and plays an invaluable part in the teaching-learning process, but learning is an interactive process and requires the involvement of the students as well. The present investigation has focused on the nonverbal behavioral role of the student in increasing cognitive learning. The results suggest that students who are physically involved in the content of the lecture score higher on their exams than students who only listen to the lecture even though those students receive similar examples and similar levels of immediacy. Consequently, future studies should address the nonverbal participation of both the students and the teacher with respect to cognitive learning.

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Table 1Distribution and Frequencies for the Quizzes

	Mean	SD	Range	Skew	Kurt	Variance
Quiz One (the pre-test)	6.70	2.08	8.00	-.64	.72	4.32
Quiz Two (the post-test for Experiment One)	6.41	2.08	8.00	-.01	.74	4.35

Table 2

Results of the Post-test

	Mean	F	df	eta
Group One (control group)	5.6			
		8.32	1/38	.43
Group Two (experimental group)	7.3			

p < .05